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TECHNICAL MEMORANDUM

DATE: January 16, 2003

TO: Kevin Parrett, Oregon Department of Environmental Quality (DEQ) Northwest (NW) Region, Portland, Oregon

FROM: Heather Brunelle, Ecology & Environment, Inc. (E & E), Portland, Oregon

THROUGH: Carl Mach, E & E, Buffalo, New York

SUBJ: McCormick & Baxter Creosoting Company Site, Portland, Oregon

RE: Evaluation of Surface Water Cleanup Goals

cc: Susan Gardner, E & E, Seattle, Washington
John Montgomery, E & E, Portland, Oregon
Michael Poulsen, DEQ NW Region, Portland, Oregon
Site File

1. Introduction

Ecology and Environment, Inc. (E & E), under contract with the Oregon Department of Environmental Quality (DEQ), has prepared this Technical Memorandum to provide recommendations for surface water cleanup goals for protection of aquatic life for contaminants of concern (COCs) at the McCormick & Baxter Creosoting Company (McCormick & Baxter) site in Portland, Oregon. This technical memorandum is based on scoping meetings with Agency representatives, a review of State and Federal Ambient Water Quality Criteria (AWQC) and other surface water screening benchmarks, and a review of published scientific literature of toxicity studies relevant to threatened salmonids. This technical memorandum has been prepared under Task Order No. 88-97-39.

2. Review of Surface Water Screening Benchmarks

A review of AWQC and other surface water screening benchmarks was performed to identify applicable protective criteria for COCs and to identify those COCs that do not have AWQC. COCs for the McCormick & Baxter site were identified in the Record of Decision (ROD) and include metals (arsenic, chromium, copper, and zinc), pentachlorophenol (PCP), polynuclear aromatic hydrocarbons (PAHs), and dioxin/furan compounds. Only AWQC and screening benchmarks based on chronic toxicity, rather than acute toxicity, were considered in the review because releases from hazardous waste sites are often continuous and long-term. The following subsections present the findings of the review of available screening benchmarks.

2.1 Federal AWQC

Federal AWQC are listed in the second column of Table 1. The United States Environmental Protection Agency (EPA) provides federal AWQC for the protection of freshwater aquatic species in their *National Recommended Water Quality Criteria: 2002* (EPA 2002), which are considered federal promulgated standards. The AWQC for chromium, copper, and zinc are hardness dependent and were adjusted for a site-specific hardness value of 25 milligrams per liter. The freshwater AWQC for metals in Table 2 is expressed in terms of the total recoverable metal in the water column. Dissolved metal criteria were converted to total recoverable metal criteria using the conversion factors listed in Appendix A of the *National Recommended Water Quality Criteria: 2002* (EPA 2002). The AWQC for PCP is pH adjusted and was adjusted for a site-specific pH of 7.5. Site-specific hardness and pH data were obtained from DEQ's Water Quality Division's Laboratory Analytical Storage and Retrieval Database (LASAR). The mean values for hardness and pH were calculated using LASAR sampling data collected at DEQ's sampling station labeled Willamette River At Sp&S Rr Bridge (i.e., the Burlington Northern Railroad Bridge) for the time period of 1997 through 2001. The EPA (2002) does not provide AWQC for PAHs.

2.2 Oregon State Water Quality Standards

The State of Oregon provides AWQC in their Water Quality Criteria Summary (Table 20 of OAR 340-41). DEQ's Water Quality Criteria Summary, due to be updated in 2003, lists State promulgated standards for metals, PCP, and some PAHs. The standards for these COCs are listed in the third column of Table 1. The standards listed for PAHs were based on the 1996 EPA National AWQC, which is now considered outdated. DEQ does not plan on including standards for PAHs in the updated Water Quality Summary Table.

2.3 Other Screening Benchmarks

Table 1 also lists ecological screening benchmarks for aquatic receptors from the following sources:

- Screening concentrations provided by the National Oceanic and Atmospheric Administration (NOAA) *Screening Quick Reference* Tables (SQuiRTs) (Buchman 1999);
- *Level II Ecological Screening Level Values* developed to supplement DEQ's Ecological Risk Assessment Guidance (DEQ 2001); and
- *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota* compiled by Oak Ridge National Laboratory (ORNL) (Suter and Tsao 1996).

2.3.1 NOAA SQuiRTs

The fourth column of Table 1 lists the available NOAA SQuiRT benchmarks for the COCs at the McCormick & Baxter site. The NOAA SQuiRTs are intended for screening purposes only. They represent official NOAA policy but do not constitute criteria or cleanup levels (Buchman 1999). NOAA listed Federal AWQC were compiled prior to the EPA's 2002 update. Hence, several of the PAH screening benchmarks are outdated.

2.3.2 DEQ Level II Ecological Screening Level Values

DEQ's Level II Ecological Screening Level Values for freshwater (DEQ 2001) are intended to screen COCs based on available toxicity information and do not represent cleanup criteria. DEQ's Level II Ecological Screening Level Values are available for arsenic, chromium, copper, zinc, and PCP (based on 1999 National AWQC) and several PAHs (based on OAR 340-041 Table 20 values and ORNL Tier II Secondary Values for chronic toxicity). DEQ (2001) listed the ORNL Tier II Secondary Value based on acute toxicity for anthracane (0.13 micrograms per kilogram [µg/L]) rather than the Tier II Secondary Value based on chronic toxicity (0.73 µg/L). This appears to be an oversight. Also, the DEQ Level II values for acenaphthene and naphthalene are based on the OAR 340-041 Table 20 values, which will be eliminated in the next update of Table 20. The DEQ Level II Ecological Screening Level Values for freshwater are listed in the fifth column of Table 1.

2.3.3 ORNL Tier II Toxicity Benchmark Values

ORNL (Sutter and Tsao 1996) compiled toxicological benchmark values from numerous sources including the 1996 Federal AWQC; Tier II Secondary Values; and the Lowest Chronic Values for all organisms and groups of organisms including fish, daphnids, non-daphnid invertebrates, and aquatic plants. For some chemicals, ORNL applied the Tier II method, described in EPA's *Proposed Water Quality Guidance for the Great Lakes System* (EPA 1993), to develop screening benchmarks. The Tier II methods were developed by EPA so that aquatic benchmarks could be established with less data than required for developing the Federal AWQC. The benchmarks derived with these methods are termed Tier II secondary values.

The sixth column of Table 1 lists screening benchmarks from ORNL (Sutter and Tsao 1996) for the COCs at the McCormick & Baxter site. The DEQ (2001) Level II Ecological Screening Level Values are based primarily on the ORNL values. Table 1 lists eight PAH screening benchmarks from ORNL. However, only five of these values are presented as clean-up goals in Table 2. For anthracene, benzo(a)anthracene, and benzo(a)pyrene, the Tier II Secondary Values calculated by ORNL were based on limited toxicity data that included one to two studies. As such these values are highly uncertain and are not recommended for use as cleanup goals. Attachment 1 shows the derivation of the Tier II values for these three PAHs and for naphthalene.

The Tier II secondary chronic value for naphthalene is based on a larger database and is much less uncertain than those for anthracene, benzo(a)anthracene, and benzo(a)pyrene. The other four chronic PAH benchmarks taken from ORNL were calculated by EPA using their methods for deriving water quality criteria (acenaphthene, flouranthene, phenanthrene) or the Tier II methodology (fluorene). Overall, it appears that the ORNL chronic screening benchmarks for five PAHs (acenaphthene, fluoranthene, flourene, naphthalene, and phenanthrene) are based on enough data to be suitable as preliminary surface water clean-up goals for the site. The values ORNL derived for anthracene, benzo(b)fluoranthene, and benzo(a)pyrene were developed using only limited data and are not recommended as cleanup goals.

2.4 Scientific Literature

A scientific literature review was performed to identify protective water quality criteria for those COCs without AWQC. The reviewed literature primarily consisted of toxicity

studies provided by NOAA and DEQ. A limited search for other relevant studies was also done. Attachment 2 provides a list of the papers reviewed.

The scientific paper 'Technical Basis for Narcotic Chemicals and Polycylic Aromatic Hydrocarbon Criteria. I. Water and Tissue' (Di Toro et al. 2000) presented a method for developing AWQC for type 1 narcotic chemicals in general and PAHs in particular. The derived AWQC can be applied to any individual or mixture of narcotic chemicals using only the chemical's octanol-water partition coefficient (K_{OW}). The AWQC were derived from a database of LC50s comprising 156 chemicals and 33 freshwater and saltwater species, including fish, amphibians, arthropods, mollusks, polychaetes, coelenterates, and protozoans. Di Toro et al. (2000) developed a target lipid model to account for variations in toxicity due to differing species sensitivities and chemical differences in the derivation of target lipid LC50 body burdens. Acute-to-chronic ratios were calculated to provide FCVs as the AWQC.

Since Di Toro et al. (2000) derived FCVs using both saltwater and freshwater species, E & E recalculated FCVs using only the freshwater species in the database in order to evaluate the protectiveness of the FCVs to the freshwater species of the Willamette River. The spreadsheets used to recalculate the FCVs using only the freshwater species are provided as Attachment 3. The recalculated values, using only freshwater species, increased from those provided by Di Toro et al. (2000). Both sets of values are provided in Table 1 (see last two columns). E & E recommends using the values given by Di Toro et al. (2000) for both saltwater and freshwater species, rather than those calculated with just the freshwater species data, for the following reasons:

- Di Toro et al. (2000) stated that, "we judged that, with the larger data set (freshwater and saltwater species), the estimate of the universal narcosis slope would be more robust and that the WQC would be more representative";
- By excluding the saltwater test data, the four most sensitive test species (i.e. the four species at the top of Table 2 in Di Toro et al. [2000]) are excluded, which will tend to drive the AWQC higher;
- The endangered salmon species in the Willamette River are anadromous (i.e. they are both freshwater and saltwater in nature).

The second to last column of Table 1 lists the PAH FCVs from Table 6 in Di Toro et al. (2000). Di Toro et al. (2000) list the PAH FCVs in units of moles per liter, so the units were converted to micrograms per liter using molecular weights. A uniform method was used by Di Toro et al. (2000) to compile the criteria for each of the PAH compounds and the study is relatively recent. A toxic unit approach could be used to determine if the concentrations of PAHs present in surface water and/or porewater samples from the site constitute a toxic mixture. The FCVs could also be used individually for modeling purposes.

Di Toro et al. (2000) did not develop FCVs for two PAHs of concern at the McCormick & Baxter site -- benzo[k]fluoranthene (log Kow = 6.3) and benzo[g,h,i]perylene (log Kow = 6.5) -- because their toxicity is limited by aqueous solubility. Also, Di Toro et al. (2000) did not list a FCV for ideno[1,2,3-cd]pyrene (log Kow = 7.66 [Novotny and Olem 1994]). Based on the reported log Kow of ideno[1,2,3-cd]pyrene, its chronic toxicity is also most likely limited by aqueous solubility.

3. Recommendations

E & E proposes the following preliminary surface water cleanup criteria for the McCormick & Baxter site:

1) EPA (2002) National Recommended Water Quality Criteria for arsenic, chromium, copper, zinc, and PCP;

2) ORNL (Suter and Tsao 1996) chronic benchmarks for naphthalene, acenaphthene, flouranthene, fluorene, and phenanthrene, which in most cases are the same values used by DEQ (2001) as Level II Ecological Screening Level Values;

3) DEQ OAR 340-041 Table 20 Water Quality Criteria for dioxin/furan compounds; and

4) The FCVs from Di Toro et al. (2000), derived using both freshwater and saltwater species, for the remaining COCs.

The proposed surface water cleanup goals are listed in Table 2.

4. References

Di Toro, D.M., J.A. McGrath, and D.J. Hansen, 2000, Technical Basis for Narcotic Chemicals and Polycyclic Aromatic Hydrocarbon Criteria. I. Water and Tissue, *Environ. Toxicol. Chem.* **19**:1951-1970.

Buchman, M.F., 1999, *NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, Washington*, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration.

Novotny, V. and H. Olem, 1994, *Water Quality Prevention, Identification, and Management of Diffuse Pollution*, Van Nostrand Reinhold, New York, New York.

Oregon Department of Environmental Quality (DEQ), 2001, *Guidance for Ecological Risk Assessment*, Land Quality Division, DEQ, Portland, Oregon.

Suter, G.W. and C.L. Tsao, 1996, *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision*, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, ES/ER/TM-96-2.

United States Environmental Protection Agency (EPA), 2002, *National Recommended Water Quality Criteria: 2002*, Office of Water, EPA, EPA-822-R-02-047.

_____, 1993, Water Quality Guidance for the Great Lakes System and correction; Proposed Rules, *Federal Register*, **58**(72):20802-21047.

Table 1
McCormick & Baxter Creosoting Company
Portland, Oregon
Comparison of Surface Water Cleanup Criteria based on Effects to Aquatic Life

Contaminants of Concern (COCs)		*EPA (2002) National Recommended Water Quality Criteria/* Freshwater CCC	*Surface Water* Water Quality Criteria for Willamette River/Aquatic Life[a]	*NOAA (1999) SQuiRTs Table/ Freshwater CCC*	*Surface Water* - DEQ (2001) Level II Ecological Screening Level Values[b]	*Oak Ridge National Laboratory TM-96/R2 [1996] Table I Values*	*Di Toro et al. (2000) Freshwater and Saltwater Species FCV (ug/L)*	*Di Toro et al. (2000) Freshwater Species FCV (ug/L)*
Dioxins/Furans		--	3.8×10^{-5}	--	--	--	--	--
Pentachlorophenol		15[c]	13[c]	15[c]	15[c]	--	--	--
Arsenic		150[e,f]	190	150[e,f]	150[e,f]	190[i]	--	--
Chromium		77.3[e,g]	210[d]	77.3[e,g]	77.3[e,g]	210[i,d]	--	--
Copper		3.75[e,g]	12[d]	3.75[e,g]	3.75[e,g]	12[i,d]	--	--
Zinc		33.5[e,g]	110[d]	33.5[e,g]	33.5[e,g]	110[i,d]	--	--
Polynuclear Aromatic Hydrocarbons								
Acenaphthene	L	--	520	520	520	23[i]	95.1	161
Acenaphthylene	L	--	--	--	--	--	528	887
Anthracene	L	--	--	--	13[k]	0.73[h]	35.6	60.0
Benzo[a]anthracene	H,C	--	--	--	0.027[h]	0.027[h]	3.79	6.44
Benzo[b]fluoranthene	H,C	--	--	--	--	--	1.13	1.93
Benzo[k]fluoranthene	H,C	--	--	--	--	--	--	--
Benzo[a]pyrene	H,C	--	--	--	0.014[h]	0.014[h]	1.59	2.73
Benzo[g,h,i]perylene	H	--	--	--	--	--	--	--
Chrysene	H,C	--	--	--	--	--	3.46	5.90
Dibenz[a,h]anthracene	H,C	--	--	--	--	--	0.48	0.82
Fluoranthene	H	--	--	--	6.16[i]	6.16[i]	12.2	20.6
Fluorene	L	--	--	--	3.9[h]	3.9[h]	66.2	112
Ideno[1,2,3-cd]pyrene	H,C	--	--	--	--	--	--	--
Naphthalene	L	--	620	620	620	12[h]	322	551
Phenanthrene	L	--	--	6.3	6.3[i]	6.3[i]	32.4	55.0
Pyrene	H	--	--	--	--	--	17.2	29.2
Total LPAHs		--	--	--	--	--	--	--
Total HPAHs		--	--	--	--	--	--	--
Total Carcinogenic PAHs		--	--	--	--	--	--	--
Total PAHs		--	--	--	--	--	--	--

Table 1
McCormick & Baxter Creosoting Company
Portland, Oregon
Comparison of Surface Water Cleanup Criteria based on Effects to Aquatic Life

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Footnotes:
Values are provided in micrograms per liter (ug/L).
L = low molecular weight PAH (LPAH); H = high molecular weight PAH (HPAH); C = carcinogenic PAH
CCC = Criterion Continuous Concentration, which is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.
Reverse font indicates COC will need to be addressed under Task 2.1, 88-97-39.
-- – indicates that surface water quality criteria are not provided for listed COC.
DiToro et al. (2000) recommend that these criteria be used to evaluate the additive toxicity of PAH mixtures using a toxic unit approach.

[a] Water Quality Criteria for the Willamette River/Aquatic Life were obtained from OAR 340-41, Table 20 as specified in the Record of Decision. The values used in this table are for chronic exposure.

[b] Fresh Surface Water Level II Screening Level Values listed are for aquatic receptors. Obtained from DEQ's Guidance for Ecological Risk Assessment (updated December 2001).

[c] pH Dependent Criteria (pH 7.8 used).

[d] Hardness Dependent Criteria (100mg/L used).

[e] Freshwater criteria for metals are expressed in terms of the total recoverable metal in the water column.

[f] Water quality criterion was derived from data for arsenic (III), but is applied to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive.

[g] Hardness Dependent Criteria (25 mg/L used).

[h] ORNL TM-96/R2 [1996] Table I (Tier II secondary chronic value).

[i] ORNL TM-96/R2 [1996] Table I (NAWQC chronic value).

[k] ORNL TM-96/R2 [1996] Table I (Teir II secondary acute value).

Table 2
McCormick & Baxter Creosoting Company
Portland, Oregon
Proposed Clean-up Goals

Contaminants of Concern (COCs)		*Applicable State and Federal Water Quality Criteria (ug/L) CCC: SURFACE WATER*	*Oak Ridge National Laboratory TM-96/R2 [1996] Table I Values: SURFACE WATER*	*Di Toro (2000) Final Chronic Values: SURFACE WATER*	*Applicable AWQC x 5: POREWATER* (ug/L)	*Oak Ridge National Laboratory TM-96/R2 [1996] Table I Values x 5: POREWATER*	*Di Toro (2000) Final Chronic Values x 5: PORE WATER*
Dioxins/Furans		3.8×10^{-5}[a]	--	--	1.9×10^{-4}[a]	--	--
Pentachlorophenol		11.1[b,c]	--	--	55.5[b,c]	--	--
Arsenic		150[b,d,e]	--	--	750[b,d,e]	--	--
Chromium		77.3[b,d,f]	--	--	386.5[b,d,f]	--	--
Copper		3.75[b,d,f]	--	--	18.75[b,d,f]	--	--
Zinc		33.5[b,d,f]	--	--	167.5[b,d,f]	--	--
Polynuclear Aromatic Hydrocarbons							
Acenaphthene	L	--	23[g]	--	--	115[g]	--
Acenaphthylene	L	--	--	528	--	--	2,640
Anthracene	L	--	--	35.6	--	--	178
Benzo[a]anthracene	H,C	--	--	3.79	--	--	19.0
Benzo[b]fluoranthene	H,C	--	--	1.13	--	--	5.65
Benzo[k]fluoranthene	H,C	--	--	NA	--	--	NA
Benzo[a]pyrene	H,C	--	--	1.59	--	--	7.95
Benzo[g,h,i]perylene	H	--	--	NA	--	--	NA
Chrysene	H,C	--	--	3.46	--	--	17.3
Dibenz[a,h]anthracene	H,C	--	--	0.48	--	--	2.4
Fluoranthene	H	--	6.16[g]	--	--	30.8[g]	--
Fluorene	L	--	3.9[h]	--	--	19.5[h]	--
Ideno[1,2,3-cd]pyrene	H,C	--	--	NA	--	--	NA
Naphthalene	L	--	12[h]	--	--	60[h]	--
Phenanthrene	L	--	6.3[g]	--	--	31.5[g]	--
Pyrene	H	--	--	17.2	--	--	86
Total LPAHs		--	--	--	--	--	--
Total HPAHs		--	--	--	--	--	--
Total Carcinogenic PAHs		--	--	--	--	--	--
Total PAHs		--	--	--	--	--	--